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THE EUROPEAN CENTRAL BANK: DECISION RULES AND MACROECONOMIC PERFORMANCE

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Abstract

In this paper we analyze the effects of different decision rules in the ECB on monetary stability. We consider a model where asymmetric shocks and divergent propagation of shocks on output and inflation are potential causes of tensions within the ECB concerning the conduct of monetary (interest rate) policy. Given divergence of desired interest rates (due to the asymmetries) we analyze the effect of different voting procedures within the Governing Council of the ECB. Welfare implications are discussed.

Keywords: EMU, linear feedback rules, monetary stability.

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1 Introduction

The future European Central Bank (ECB) will have the sole responsibility for the conduct of monetary policies in the EMU. Up to now relatively little analysis has been made about how the ECB is likely to conduct these policies[1]. The Maastricht Treaty provides some general principles about the objectives to be pursued by the ECB and has set the institutional framework within which the ECB will take its decisions. More precisely, the statutes of the ECB were enshrined in the Maastricht Treaty. The principles underlying these statutes are, first, that the primary objective of the ECB is the maintenance of price stability (art. 105), and, second, that in order to achieve this objective, the ECB should be politically independent (art. 107). The Treaty also formulates other objectives to be pursued by the ECB (e.g. high employment) but always adds the proviso that this should not interfere with the primary objective which is price stability.

The decision making body will be the Governing Council, which will consist of the Governors (Presidents) of the National Banks of the euro-countries, and of the President, the Vice-President and the four Directors of the ECB. Each of the members will have one vote. Thus, there will be a large representation of the different national interests.

One major issue that arises in this context is the following. Will the national representatives in the ECB-Council take a union-wide perspective when deciding about monetary policies, or will they give a high weight to national economic conditions when taking these decisions? The question is important. For, if asymmetric shocks and/or adjustment speeds occur frequently in the future EMU, a nationalistic attitude of the ECB Council members triggered by divergent economic conditions, may lead to frequent conflicts on the appropriate policies to be pursued. One can expect that, although each of the Governors will share similar preferences about inflation and output stabilization, these divergent economic conditions may lead them to take different positions on the desirable stance of monetary policies. At this moment it is unclear how the Council will decide, i.e. whether it will try to come to a consensus, or whether it will use majority voting as the preferred decision rule. In the latter case it is more likely that national viewpoints will loom large in the decision making process.[2]

In this paper we analyze some of these issues. In section 2 we develop a model that allows us to analyze the workings of the ECB under different decision rules, taking into

[1] Three recent papers analyze issues relating to the delegation of power to the European Central Bank. See Bindseil (1996), Bottazzi and Manasse (1998) and Brueckner (1997). Another paper Dornbusch, Favero and Giavazzi(1998) studies problems of voting in the ECB.

[2] For a more detailed description of the statues of the ECB see Gros and Thygesen (1997). See also Dornbusch, Favero and Giavazzi (1998).

account the possibility of asymmetric shocks and/or divergent propagation of shocks across countries. In section 3 we explain the particular voting procedures and outcomes we consider relevant for the ECB Governing Council and in section 4 we apply them to simulate the decision-making process, the resulting interest rate paths and effects on output and inflation variability. Finally, section 5 contains a summary of the main findings of the paper.

2 Optimal Policy Rules for Country Representatives

We base our analysis on recent research concerning the use of monetary policy rules in a number of industrial countries (see Taylor (1993) and Clarida, Gali and Gertler (1997)). This research indicates that central banks in industrial countries generally target the rate of inflation and are also concerned about stabilizing the business cycle. The instrument used to perform these tasks is usually the short-term interest rate. This evidence has led Taylor (1993) to conclude that central banks (in particular the US Federal Reserve) raise the short term interest rate when inflation increases and when output growth increases relative to capacity output, and vice versa. Clarida, Gali and Gertler (1997)) conclude that central banks of the major industrial countries (US, Japan, Germany, England) behave in a similar way, although the weight they attach to inflation and output varies. It is interesting to note that the Bundesbank which is the most outspoken about price stability as the primary objective of monetary policy, in practice attaches considerable importance to output stabilization (see also Bernanke and Mihov (1997), Laubach and Posen (1997), Issing (1996), Neumann (1996), von Hagen (1995) and Peersman and Smets (1998) on this issue).

In this section we set up a model for the observed central bank behavior, using the model presented in Rudebusch and Svensson (1998). The central bank is assumed to have an explicit target for the goal variables such as an inflation target and output gap target. In order to reach these targets the central banks use the short run interest rate as an instrument. The implicit rule for the instrument (from now on policy rule) can then be derived from the first order condition of the explicit loss minimization.. In general this policy rule will depend on the current economic state of the country and the way interest rate are (over time) affecting the different explicit goal variables, i.e. inflation and output. The interest rate, as determined by the policy rule, will therefore be a function of (1) the preferences of the central bank over the different macro-economic variables, (2) the transmission of interest rates into these goal variables (3) the actual state of the economy and finally (4) the shocks that alter unexpectedly the state of the economy. Each of these four components is likely to differ across countries such that optimal interest rate rules are likely to be country-specific and therefore a potential cause of tension within the ECB Governing Council.

2.1 State space representation

To make the model similar in structure to the one used by central banks we follow Rudebusch and Svensson (1998) in focusing on the following three features: (1) the policy instrument used by the central bank is the short-run interest rate (i), (2) the model is defined in terms of the output gap and (3) a standard autoregressive type of Phillips-curve is used.[3] More formally, we assume that inflation (π) is determined by the output gap ($-y$) with a one period lag and past inflation rates:

$$\pi_{t+1} = \sum_{j=1}^{n} \alpha_{\pi,j} \pi_{t+1-j} + \alpha_y y_t + \varepsilon_{t+1}. \tag{1}$$

We decompose output into a permanent and a transitory component. We interpret the permanent component of output as the output capacity of an economy. The transitory component y therefore measures the temporary over- or underutilisation of the output capacity. The percentage deviation of output from permanent output capacity is assumed to depend on previous deviations and the real interest rate over the past 12 periods. More formally:

$$y_{t+1} = \sum_{j=1}^{m} \beta_{y,j} y_{t+1-j} - \beta_i \left(\bar{i}_t - \bar{\pi}_t\right) + \eta_{t+1}, \tag{2}$$

where $\bar{i}_t$ and $\bar{\pi}_t$ denote a twelve month (moving) arithmetic average of current and past interest and inflation rates, respectively:

$$\bar{i}_t = 1/\left(12\right) \sum_{i=0}^{11} i_{t-i} \quad \text{and} \quad \bar{\pi}_t = 1/12 \sum_{i=0}^{11} \pi_{t-i}. \tag{3}$$

Note that equations (1) and (2) imply a specific transmission mechanism in response to changes in the policy instrument. More specifically, a change in the interest rate first affects the output gap and subsequently, with a one period lag, affects the inflation rate indirectly (through the effects of interest rate changes on the output gap). Evidently, transmission

[3] Note that the autoregressive type of Phillips curve is backward looking instead of the more standard, forward looking, version. Empirical evidence suggests that the former may from an empirical point of view be superior to the latter. For instance, Fuhrer (1997) finds that the backward looking version is much closer to the empirically observed inflation dynamics than the forward looking version.

of interest changes to output and inflation will be determined by the parameter values $\alpha_{\pi,j}$ and $\beta_{y,j}$ $j = 1, ..., 11$.[4]

The state of the economy and its dynamics can be summarized by the state space representation of (1) and (2). Denoting the state of the economy by X_t, an $(n + m + 11) \times 1$ vector, its dynamics can be reformulated as:

$$X_{t+1} = AX_t + Bi_t + v_{t+1} \tag{4}$$

where:

$$X_t = \begin{bmatrix} \pi_t \\ \pi_{t-1} \\ \vdots \\ \pi_{t-n-1} \\ y_t \\ y_{t-1} \\ \vdots \\ y_{t-m-1} \\ i_{t-1} \\ \vdots \\ \vdots \\ i_{t-l} \end{bmatrix} \quad A = \begin{bmatrix} \sum_{j=1}^{n} \alpha_{\pi,j} e_j + \alpha_y e_{n+1} \\ e_1 \\ \vdots \\ e_n \\ \beta_r e_{1:11} + \sum_{j=1}^{m} \beta_{y,j} e_{n+j} - \beta_r e_{n+m+1:n+m+l} \\ e_{n+1} \\ \vdots \\ e_{n+m} \\ e_0 \\ e_{n+m+2} \\ \vdots \\ e_{n+m+l} \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \\ -\frac{\beta_r}{12} \\ 0 \\ \vdots \\ 0 \\ 1 \\ \vdots \\ \vdots \\ 0 \end{bmatrix} \quad \text{and} \quad v_t = \begin{bmatrix} \varepsilon_t \\ 0 \\ \vdots \\ 0 \\ \eta_t \\ 0 \\ \vdots \\ 0 \\ 0 \\ 0 \\ \vdots \\ \vdots \\ 0 \end{bmatrix}$$

where e_j denotes a $(n + m + 11) \times 1$ vector with all elements equal to zero but the j-th equals one and $e_{i:j}$ a $(n + m + 11) \times 1$ vector with $1/12$ as element from row i up till row j and zero's elsewhere.

2.2 Optimal linear feedback rule

The central bank has as objective to minimize its intertemporal loss function which is defined in terms of the time t expected difference between (yearly) inflation, the output gap $(-y)$ and their targeted values, c_1 and c_2, respectively. Moreover, some degree of

[4] In order to satisfy the natural rate hypothesis a restriction of the α coefficients of the form

$$\sum_{j=1}^{n} \alpha_{\pi,j} = 1$$

should be imposed. In the empirical section we use the unrestricted coefficient estimates for which the summed coefficients are reasonably close to and insignificantly different from 1.

interest smoothing is assumed for the central bank. Formally, we assume the following minimization problem:

$$\min_{i_t} \sum_{j=0}^{+\infty} \delta^j E_t \left[\left(\bar{\pi}_{t+j} - c_1\right)^2 + \lambda \left(y_{t+j} - c_2\right)^2 + \gamma \left(i_{t+j} - i_{t+j-1}\right)^2 \right]. \tag{5}$$

If the frequency of meetings in the ECB is sufficiently high such that the discount rate $\delta \to 1$, it can be shown that the above minimization problem can be restated in terms of an unconditional loss function (see Rudebusch and Svensson, 1998):

$$\min_{i_t} E\left[L_t\right] = Var\left[(\bar{\pi} - c_1)\right] + \lambda Var\left[(y - c_2)\right] + \gamma Var\left[\Delta i\right]. \tag{6}$$

Again, following Rudebusch and Svensson (1998) we write the target variables, $\bar{\pi}_t$, y_t and $i_t - i_{t-1}$ in function of the state variable X_t :

$$Y_t = \begin{bmatrix} \bar{\pi}_t \\ y_t \\ i_t - i_{t-1} \end{bmatrix} = C_X X_t + C_i i_t, \text{where}\, C_X = \begin{bmatrix} e_{1:12} \\ e_{n+1} \\ -e_{n+m+1} \end{bmatrix} \text{ and } C_i = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}. \tag{7}$$

The loss function can now be rewritten as :

$$L_t = E\left[Y_t' K Y_t\right], \text{where } K = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \lambda & 0 \\ 0 & 0 & \gamma \end{bmatrix}. \tag{8}$$

Given the empirical evidence that central banks base their interest rate policy on current (and previous) values of output and inflation we consider the class of linear feedback rules, that is linear rules based on the current economic states:

$$i_t = f X_t \tag{9}$$

where f denotes a $1 \times (n + m + 11)$ vector. Using the above relations and substituting the linear feedback rule we obtain the dynamics of the state variable, taking into account the actions of the central bank (on interest rates), as:

$$X_{t+1} = M X_t + v_{t+1}, \;\; M = A + Bf \tag{10}$$

and for the goal variables:

$$Y_t = C X_t, \;\; C = C_X + C_i f. \tag{11}$$

Under the assumptions made so far, Rudebusch and Svensson show that the optimal (linear) policy rule is given by:

$$i_t = -\left(R + B'VB\right)^{-1}\left(U' + B'VA\right)X_t \tag{12}$$

where the matrix V is defined by:

$$
\begin{aligned}
V &= Q + Uf + f'U' + f'Rf + M'VM \qquad (13) \\
Q &= C_X'KC_X,\; U = C_X'KC_i \text{ and } R = C_i'KC_i.
\end{aligned}
$$

Inspection of the optimal linear feedback rule f shows that interest policies can diverge across countries for three reasons. First, the economic conditions, as summarized by the state variable, X, may differ and hence require different policy actions. The next two causes are the different propagation mechanisms across countries, incorporated in A, and country-specific preferences over inflation, output and interest rate smoothness (entering through K). Given that each individual member will try to pursue its optimal economic policy within the EMU, divergent country specific optimal rules will naturally be a source of conflict in the conduct of the European monetary policy.

2.3 Empirical results

In this section we present the estimates of the optimal linear feedback rules for the 11 EMU-members. In a first step, the country-specific propagation mechanisms as formalized in equations (1) and (2) . Estimation was performed over the period 1979:1 till 1995:12.[5] The output gap was constructed by means of a properly detrended industrial production.[6]Monthly inflation was constructed as the first difference of the log CPI indices as reported in IFS statistics. Finally, interest rates are monthly money market and call money rates (with the exceptions of STF rate for Ireland, average lending rate for Finland and lending rate for Portugal) as reported by the IFS statistics.[7]

[5]Lack of data for some variables for several countries prevented us from extending the sample to the current time.

[6]More specifically we used a multiplicative HP filter with a value for λ of 500 000. This amounted to a linear detrending exercise for most countries involved. Only for Ireland we found evidence of a nonlinear trend. The output gap was then constructed by taking the logaritmic transform of the transitory part of the multiplicative HP filter. The resulting series captures very well the business frequency. Data and figures on the output gap are available upon request.

[7]We asssume also that Belgian interest rate applies in Luxembourg.

For reasons of brevity we do not present the parameter estimates for all countries considered. As for our purpose, the presence of asymmetric propagation of shocks is of greater importance, we present the effects of interest rate changes on output and inflation for each of the countries. More specifically, we depict the reaction of output and inflation to an increase of the interest rate by one percent during three consecutive years. Results are presented in figure 1.[8] As can be inferred from these figures, most countries behave as expected to an increase in the interest rate. Both the output and the inflation decrease as a consequence of the increase in interest rates. Moreover, in line with the literature, we find for all countries that the output response is larger than that of inflation. Also as is obvious from figure 1, the size of responses as well as the propagation of the increase in the interest rate differ considerably across countries. For some countries, notably Belgium and Ireland, we observe the so-called price puzzle (see Fuhrer (1997) and Christiano, Eichenbaum and Evans (1994)). That is, the price response to an increase in the interest rate is perverse, i.e. the price level increases (slightly) in response to an interest rate shock.

Insert Figure 1

The optimal feedback rule for interest rates depends on both the reduced-form dynamics and the preferences of the central bank. In this paper we consider four types of central bankers, represented by different sets of preferences. More specifically we normalize the weight on inflation variability to 1 and consider four parameter combinations for the weight attached to output variability and the variance of interest rate shocks: $(\lambda, \gamma) : (0.2, 0.5)$, $(1, 0.5)$, $(5, 0.5)$ and $(1, 0.25)$. The optimal feedback rules, see equation (12), are presented in tables 1 to 5.

INSERT TABLES 1 TILL 5

Some observations are worth stating. First, according to the estimates in tables 1 to 5, the weight on output is considerably higher than the one on inflation. The weight on output is about three to eight times as large as the one on output depending on the country considered. This is clearly at odds with the standard Taylor rule, prescribing equal weights on output and inflation. This finding is, however, qualitatively in line with the findings of Peersman and Smets (1998), who find a factor three for quarterly data.[9] Second, and in

[8] Regression diagnostics were reasonable for all estimated equations. No significant signs of remaining autocorrelations were reported. The R^2 for the output equation were relatively high explaining on average about 60% of variation. The R^2 for the inflation regressions were somewhat lower with an average around 40%.

[9] Estimating the optimal feedback rule for Germany on quarterly data we obtained coefficients close to the ones of Peersman and Smets (1998), corroborating the relatively large weight on output.

line with the intuition, the output coefficients in the feedback rules tend to increase with the weight on output stabilization (λ). Third, note that for our monthly data we obtain large coefficients on the one period lagged interest rate, implying a relatively inert interest rate process. Obviously, the weight on the lagged interest rate increases with the weight put on interest rate smoothing (γ).(compare tables 1 and 2).

3 Institutional Framework: ECB Decision Rules

Decisions about the monetary policy (the short run interest rate) will be taken by the Governing Council of the ESCB. It consists of 17, i.e. 11 governors of the national central banks who represent the national interests at the council meetings and 6 members of the ECB Board who will most likely take a European wide view and act accordingly. A natural implication of this institutional set-up is that 12 desired interest rates will co-exist, a European-wide interest rate proposed by the ECB-board and 11 national desired interest rates. The Governing Council will meet regularly (around once a month) to vote upon the short run interest rate as the main policy tool.[10]

So far it has not been decided which voting procedure will be adopted by the Governing Council. We assume that a procedure akin to the one used in the FED or the Bundesbank will be withheld. These procedures are in their essence characterized by the following sequence of events. We assume that the ECB-board through its president has the prerogative to propose the policy (i.e. the interest rate applicable in all EMU-countries) to be implemented each period. This proposal is assumed to be always backed by the six council members of the board. We assume further that the proposal will be accepted by the council unless there is a majority (at least 9 members) opposing it.[11] In the case of an opposing majority the ECB board breaks the opposing majority by a second proposal which exactly equals the desired interest rate of the country closest to the original ECB proposal. This second proposal will then be accepted by lack of opposition.

The above decision procedure boils down to a median voter model. In order to see this, rank the desired interest rates for each of the 17 members[12] in ascending order, to give

[10] For example, the Federal Open Market Committee (FOMC) is the chief policymaking body of the US Federal Reserve . Its membership consists of the seven members of the Board of Governors, the president of the Federal Reserve Bank of New York and four Reserve Bank presidents, who serve on a rotating basis. The FOMC meets eight times a year. In Germany, the Bundesbank Council is the decision making body and consists of the President and Vice-President of the Bundesbank, the six members of the Directorate and the nine Presidents of the Land Central Banks. Its meetings generally take place on alternate Thursdays.

[11] Note that a majority of 9 countries in this model will only exist if at least 9 countries all have desired interest rates higher (lower) than the one decided by the ECB.

[12] Desired interest rates for permanent ECB members are obviously identical. More specifically they are

the ordered sequence of desired interest rates $d_t^{(1)} \leq d_t^{(2)} \leq \cdots \leq d_t^{(17)}$. Note that as long as the nine-th ordered desired interest rate is the one proposed by the ECB, an opposing majority of nine or more members will never exist since at most eight desired interest rates will be lower (higher) than the ECB proposal. Next, suppose that a majority of at least nine countries exists. It is easy to see that in order to break the majority the ECB must accommodate its interest rate policy to that of the nine-th ordered desired interest rate. In other words the ninth country's desired interest rate will under the decision scheme sketched above always be the actual interest rate policy of the ECB board.

Next to the voting procedure we also have to model the perspective of each of the representatives in the Governing council. Here we make the distinction between a EMU perspective and a nationalistic perspective.

In the case of a nationalistic perspective the representative has a desired interest rate equal to the optimal interest rate of his country. That is for the representative of country j with a nationalistic perspective the desired interest rate is given by:

$$d_{t,j} = -\left(R_j + B_j' V_j B_j\right)^{-1} \left(U_j' + B_j' V_j A_j\right) X_{t,j}, \tag{14}$$

where the subscript j represents the variable relevant for country j. If the representative takes an EMU-wide perspective he will consider the situation in the union as a whole and construct a desired interest rate most apt to the EMU-wide state of the economy. We assume, as a short cut, that this desired interest rate can be represented as a weighted average of the country-specific desired interest rates:

$$d_{t,EMU} = \sum_{j=1}^{11} w_j d_{t,j}, \tag{15}$$

where w_j is the weight attached to country j, which is taken as the normalized share of the capital of the national central banks in the ECB.[13] Obviously, the final outcome of the voting will both depend on the voting procedure, which is median voter[14], and on the attitude (perspective) that each of the representatives in the Governing Council takes.

In the simulations we will consider the following scenario's:

given by $d_t = i_t^E$.

[13] These weights are a function of the country's population and GDP in EMU-wide population and GDP. As such they can be taken as relevant proxies for the weight each country gets in the decision taken by a representative with an EMU-wide perspective. The weights are for Austria 0.0299, Belgium 0.0366, Finland 0.0177, France 0.2138, Germany 0.3093, Ireland 0.0106, Italy 0.1896, Luxemburg 0.0019, The Netherlands 0.0542, Portugal 0.0244 and Spain 0.1119.

[14] Median voter models have also been considered by others as a likely outcome of the voting procedure, see for instance Von Hagen (1998).

- Consensus: Each representative takes an EMU-wide perspective. Under this rule, all desired interest rates coincide with the EMU-wide average $d_{t,EMU}$. No tensions will be observed since the first proposal of the ECB-president will always be accepted;

- ECB Rule: Representatives of the individual central banks in the Governing Council take a nationalistic perspective (i.e. use $d_{t,j}$) while the six ECB-board members take an EMU wide perspective (i.e. $d_{t,EMU}$). In this case, the ECB-board aggregates individual desired interest rates and proposes this average as the policy to be implemented. Only if at least nine representatives oppose, a second (median voter) proposal will be made by the president;

- Nationalistic case: All representatives (the 11 representatives of the individual central banks and the 6 members of the ECB-board) all take a nationalistic perspective. The outcome of the voting procedure boils down to a median voter outcome.[15]

4 Voting procedures, interest rates and macro-economic performance: simulation results

So far, we have modelled the country-specific desired interest rates and the voting procedures. In this section we look into the macro-economic effects of the different voting procedures on the different countries. We analyze the three scenario's listed above: the consensus rule, the ECB Rule case and the nationalistic case.

In order to assess the economic effects we look at welfare (the loss function) and its components for each of the member states taking into account the asymmetries in the shocks and their propagation across the different member states. As a (crude) gauge for these values we computed the loss and the variability of its components under the assumption that each country could pursue its own monetary policy and would therefore follow its own optimal feedback rule.

Some remarks with respect to the simulations are in order. First, regarding the shocks, we assume that inflation shocks act on an EMU-wide basis. That is we assume that these shocks are identical across countries. The adjustment paths of inflation and output and the structure of the output shocks across the union are assumed not to be affected by the creation of EMU.

[15] Note that the current ECB-board will consist of Dutch, French, Finnish, German, Italian and Spanish central bankers.

In order to account for the output comovements across the member states we use the residuals η of the output gap equation (2)for each country. The pairwise correlation among the residuals can be measured as:

$$s_{xy} = \frac{\sum_i \left(\eta_{xi} - \overline{\eta}_x\right)\left(\eta_{yi} - \overline{\eta}_y\right)}{n-1}. \tag{16}$$

Thus, for the covariance matrix of the European Union 11 we can write $S = [s_{ij}]$. A particularly useful decomposition of the matrix S is the Cholesky decomposition $S = LL'$,where L is a lower triangular matrix. The Cholesky decomposition is tabulated in appendix A. In the simulations we construct output shocks with the same covariance structure as observed in the past. Formally, this covariance structure can be recovered by constructing a vector of output shocks $\eta_t = [\eta_{1,t}, ..., \eta_{11,t}]' = L\varepsilon_t$, where ε is a univariate standard normal stochastic variate.

We thus look at the *hypothetical* case where for instance institutional structures or composition of production remain the same as before the creation of EMU. The exercise is however relevant as a first guess as we would following Peersman and Smets (1998) argue that the establishment of the ECB is not a totally new environment since a relatively long period of monetary convergence has preceded it.

4.1 Interest rate behavior

First, we look at the effect of the voting procedures on the ensuing interest rates as decided by the ECB Governing council. The phase spaces for the interest rates are depicted in Figure 2. These phase spaces resemble very much an AR(1) process close to a unit root. In fact estimated AR-coefficients are of the order of 0.99. This time series characteristic is observed independently of the voting procedure. Whether representatives take a nationalistic or EMU wide perspective does not matter in this respect.

Where the voting procedures start to matter is in the correlation of each of the country's desired interest rate with the decided EMU interest rate. Table 5 presents the correlation matrix of desired interest rates across countries.

Insert table 5

Some issues stand out. First, in the ECB Rule case, i.e. the situation where only the ECB-board members take an EMU-wide perspective, the proposal of the board will be accepted almost always. In our simulations we obtained successful opposition only in about 1 in 1000 to 5 in 1000 cases. This obviously is due to the fact that the ECB averages desired interest rates and that a successful opposition exist only if at least nine countries have desired interest rates higher (lower) than the board's proposal. So, unless desired interest rates are extremely skewed, the ECB Governing Council's proposal will be accepted.

Second, if, as we assume in the ECB Rule case, board members weigh the countries by their economic importance, the changes in decided interest rates will correspond closely with the desired interest rate changes for the larger countries of the union. For instance, in the base case ($\lambda = 1$, $\gamma = .5$) we find a correlation between decided and desired interest rates between 87% (Germany) and 92% (Spain). The mean absolute deviations of desired interest rates from decided interest rates (not reported but available on request) are moreover less than 1% indicating that the ECB Rule voting scheme actually allows the bigger countries to impose their desired interest rates on the union as a whole. For the smaller countries, this correlation becomes smaller (and the mean absolute deviation of decided from desired interest rates larger), indicating that their optimal policies are not so much incorporated into the ECB-board's proposal, as exemplified by Portugal and Luxemburg.

Third, in general, larger countries *loose* in importance when all the members of the Governing Council (including the board members) hold a nationalistic perspective. This feature of the model is not hard to understand. Note that the voting power of the larger countries, represented in the board is effectively reduced if one goes from the ECB Rule case to the nationalistic case. That is, since the conditions are such that the ECB proposal in the ECB Rule case almost always dominates, it is the relative weight of the desired interest rates in the ECB-board's proposal that determines the effective voting weight of a country. These weights are high for the larger countries, (France 0.21, Germany 0.3). In the nationalistic case some countries, such as Germany and France will be represented by two representatives, which give them a 'voting power' of 2/17, which is smaller than the weights they have in the alternative case.

4.2 Welfare Analysis

4.2.1 Symmetric preferences

The main result obtained from the simulations under the three voting procedures is that, they do matter. This fact is illustrated for the base case ($\lambda = 1, \gamma = .5$) in table 8.[16]

[16]Note that we do no longer present the case of the consensus rule separately. Given the discusssion in the previous section, it is obvious that all relevant values will almost exactly coincide with those reported under the heading median voter. Results for the consensus rule are available upon request.

Table 8 presents the variability of output, inflation and interest rate shocks as well as their aggregation into the loss function for each of the EMU-member states. As a gauge the table also presents the values for these quantities under the assumption that each country would follow an independent monetary policy (i.e. implement its own optimal linear feedback rule).

Insert tables 6 TILL 9

Consider first the so-called benchmark case. This case corresponds to the situation in which each country decides independently on its own monetary policy (interest rate). Obviously, since the country can independently set its interest rate to minimize its loss function, losses for the benchmark case will be lower than those incurred under an EMU-wide interest rate policy. As can be inferred from tables 6, losses under the benchmark case are indeed the lowest. [17] Note that, although the differences between losses under the independent monetary policy and the ECB Rule are in absolute value relatively small, the percentage increase in the loss is considerable for some countries, ranging from a low 0.1% to 14% for France. The increase in loss is mainly due to an increase in the variability of output. Inflation variability remains in general unaltered by the creation of an ECB using median voter procedures.

The nationalistic rule, moreover, increases the loss relative to the ECB Rule case for most EMU-countries in the base case. Note that this increase in loss obtains because of substantial increases in both the inflation and output variability. A tentative interpretation for this result goes a follows. We argued in the previous section that the change from a ECB Rule procedure to a nationalistic case effectively decreases the weight of the larger countries in the decision process. Therefore, smaller countries get implicitly a larger weight in the decision process, which in turns implies that the decided interest rate will be a more equally weighted average of the desired interest rates.[18] As a result, interest rates are less likely to remain an effective instrument for stabilizing output and inflation, unless all countries face similar economic conditions. The latter condition is unlikely to occur taking into account the asymmetric structures across countries (see section 2).

A closer look at table 5 reveals that the correlations between desired and decided interest rates decreases with the weight attached on output stabilization. That is, the higher the importance of output stabilisation, the lower, in general, the correlation between the (country-specific) desired and actually implemented interest rate policies. This means

[17] Note also that this holds for all alternative specifications for the parameters of output stabilization and interest rate smoothing. (see tables 6 till 9)

[18] And therefore make interest rate variability smaller under relatively general conditions.

that the more individual countries care about output stabilization the more often they are likely to be frustrated by the ECB decisions. This feature of the model has its origin in the optimal feedback rules presented in tables 1-4. When countries attach a higher weight on output stabilisation we observe a systematic increase in the output coefficients and a systematic decrease in the interest rate coefficients. As a result, asymmetric output shocks become more important and (common) past interest rates and inflation shocks become relatively less important. Therefore the scope for divergent desired interest rate policies increases. Thus as individual countries increase their desire to stabilize output more conflict is likely to occur. Note also that interest rate variability increases as the weight on output stabilisation increases. This increase in the interest rate variability however does not lead to a general decrease in output variability. Output variability increases for some countries and decreases for other countries. We can therefore conclude that the interest rates become on average a less effective instrument to stabilize output when individual countries increase their desire to stabilize output. This result is not surprising since the increase in interest rate variability is generated by an increase in the weight of output shocks, which have a strong country specific component.

4.2.2 Asymmetric preferences

An interesting extension concerns how welfare is affected when countries have asymmetric preferences. In tables 10 and 11, we tabulate this case where some countries are assumed to have a higher weight on output ($\lambda = 5, \gamma = 0.5$) and some lower weight ($\lambda = 1, \gamma = 0.5$). Countries assumed to have a concern of a higher output stabilization are France, Ireland, Italy, Portugal and Spain, whereas Austria, Belgium, Finland, Germany, Luxembourg and Netherlands are assumed to have a lower weight.

First of all, in this case, countries in general experience higher losses with the ECB rule. The losses under ECB Rule with asymmetric preferences are in general higher compared with the respective cases with symmetric preferences. Only Italy, Portugal and Spain seem to benefit from the asymmetric preferences and have a lower loss. The results with the nationalistic rule are somewhat mixed, i.e. some countries gain some countries loose when preferences are asymmetric.

Second, when we compare the results of table 5 with those of table 10, we observe that the change in losses are closely related with changes in the correlation between desired and decided interest rates. When countries are less harmed with the decisions of the ECB Council (thus a higher correlation between desired and decided interest rates), losses tend to come closer to their respective benchmark results.

4.2.3 Symmetric versus asymmetric shocks

Finally, we look at the effects of changes in the correlation of output shocks on the macroeconomic performance of the member states. Various authors have argued that in case of full monetary integration, the industrial composition of a country is likely to be affected as well. In which direction is however a matter of debate. Some authors believe that monetary and economic interdependence lead to regional concentration and agglomeration effects, thereby intensifying the asymmetry of shocks. [19] Others have argued that countries will more similar as a consequence of monetary union so that shocks will be more symmetric than today.[20]

In our simulations we analyze the implication of these two opposing hypothesis by allowing shocks to be either fully symmetric or fully asymmetric.

Formally, we model output shocks $\boldsymbol{\eta}_t = [\eta_{1,t}, \ldots.., \eta_{11,t}]'$ as a convex combination between a union wide output shock ε and a vector of country specific shocks $\boldsymbol{\xi}_t = [\xi_{1,t}, \ldots.., \xi_{11,t}]'$:

$$\boldsymbol{\eta}_t = \alpha \begin{bmatrix} \sqrt{\sigma_1^2} & 0 & \cdots & 0 \\ \sqrt{\sigma_2^2} & 0 & \cdots & 0 \\ \vdots & \vdots & \cdots & \vdots \\ \sqrt{\sigma_{11}^2} & 0 & \cdots & 0 \end{bmatrix} \varepsilon_t + (1-\alpha) \begin{bmatrix} \sqrt{\phi_1} & 0 & 0 & 0 \\ 0 & \sqrt{\phi_2} & 0 & \vdots \\ \vdots & 0 & \ddots & 0 \\ 0 & \cdots & 0 & \sqrt{\phi_{11}} \end{bmatrix} \boldsymbol{\xi}_t, \ \varepsilon \sim N(0,1) \ \text{and} \ \boldsymbol{\xi} \sim N$$

with σ_i^2 the unconditional variance of the output shocks of country i and $\phi_i = (1-\alpha^2)(1-\alpha)^{-2}\sigma_i$, where α is the asymmetry parameter. The latter condition makes sure that the variances of the shocks are identical to the one observed in the data and therefore allows us to do welfare (cross-table) comparisons. A fully symmetric regional shock is defined by $\alpha = 1$ and a fully asymmetric one by $\alpha = 0$.

The results are presented in tables 12 and 13 for the base case for the ECB Rule $(\lambda = 1, \gamma = 0,5)$. We show two extreme cases. When all countries face symmetric output shocks our simulation results indicate that the losses tend to decline quite substantially with respect to the base case in table 8. This is not really surprising since under symmetry the desired interest rates of the participants will be closer to each other than under higher degrees of asymmetry.

On the other hand, when output shocks are entirely idiosyncratic, countries losses tend to increase with respect to the base case as shown in table 8. In addition under asymmetry the correlation between the desired and decided interest rates declines relative

[19] See Krugman (1991) on this.

[20] See, for instance, European Commission (1990) and Frankel and Rose (1996)

to the symmetry case. Thus, under asymmetry individual countries are more frustrated by the ECB decision than under symmetry, and they experience larger welfare losses.

5 Conclusions

In this paper we analyzed the effects of different voting procedures in the Governing Council of the ECB on the economic conditions and the welfare in the different member states. Voting procedures will be required to resolve the possible tensions which may arise within the Governing Council. Such tensions are most likely to appear given the constitution of the board, i.e. eleven representatives of the national central banks and six ECB-board members. To make our case we allowed current asymmetries in shocks and their propagation to remain at the level which they have today. At this moment it is difficult to know whether asymmetry will increase or decrease in the future.

In order to assess the possible tensions that may arise from the existing asymmetric conditions across countries we derived the implied desired interest rates based on the optimal linear feedback rules as proposed by Rudebusch and Svensson (1998). These asymmetric economic conditions then result in tensions within the Governing Council concerning the appropriate policy actions. We find that the correlation between the actual decided interest rate and the country-specific desired interest rates is generally highest for the larger countries, such as Germany, France, Italy and Spain. However, the actual voting procedure crucially affects these correlations.

From a welfare perspective, the simulations seem to indicate that voting procedures do matter. The strict nationalistic case, i.e. the scheme where each representative would vote based on national interests is clearly inferior to the two alternatives considered. We argued that this feature comes from the fact that decided interest rates will incorporate more equally the desired interest rates of all countries, rendering it ineffective for stabilization purposes. In contrast, if the ECB-board members take strict Euro-wide perspective, interest rate becomes a more effective instrument, especially for inflation stabilization.

We also found that a stronger desire to stabilize output by individual countries increase their frustrations about the decisions taken by the ECB. In addition and quite paradoxically a stronger desire to stabilize output reduce the effectiveness of the interest rate to achieve this goal.

Finally, we studied what happens when the stabilization desire differs across countries. In general, such a heterogeneity of preferences reduce welfare of most participants and increases the frustration with the decisions of the ECB.

This paper neglects evidently some important features of European money markets. For instance, in the estimation of inflation and output equations we neglected the real exchange rate as a possible cause of output or inflation movements. Obviously this external source of economic fluctuations may be of considerable importance for small open economies. Incorporating the real exchange rate along the lines of Peersman and Smets (1998) seems an interesting way to account for these external forces. However, it would also increase the dimension of the state space considerably, which is large already in the current setting. We plan to pursue this route of research in the near future. Second, the optimal desired interest rate has not been derived. Instead we assumed that a proxy for this variable was given by the weighted average of the desired interest rates of the countries. The optimal desired interest rate could theoretically be obtained in much the same way as the national desired interest rates. Here the curse of dimensionality strikes again however. At the end of the day, however, we would like to argue that the approach we took is a reasonable approximation for the ECB optimal linear feedback rule.

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Appendix A: Cholesky decomposition of output shocks

Here we present the Cholesky decomposition of the matrix used in the simulations:

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
Aus	.018	.002	.0009	.0005	.0018	-.0015	.0046	.0039	.0063	-.0067	.0003
Bel	0	.0222	.0098	.0015	.0041	.0049	-.0011	.0000	.0011	.0073	.0021
Fin	0	0	.0158	-.0017	-.0004	-.0026	-.0012	-.0005	-.0011	-.0007	-.0004
Fra	0	0	0	.011	.0032	-.0049	.0009	-.001	.0005	-.0002	-.0016
Ger	0	0	0	0	.0139	-.0018	-.0007	.0024	.0008	-.001	.0026
Ire	0	0	0	0	0	.027	.0027	.0025	.0023	.0015	.001
Ita	0	0	0	0	0	0	.0221	.0068	.0032	.0089	-.0022
Lux	0	0	0	0	0	0	0	.0276	.0016	-.0022	-.0004
Net	0	0	0	0	0	0	0	0	.0211	-.0041	.0004
Por	0	0	0	0	0	0	0	0	0	.0554	-.0008
Spa	0	0	0	0	0	0	0	0	0	0	.0186

Table 1: **Optimal feedback rule (** $\lambda = 1$ **,** $\gamma = 0.25$**)**

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
	interest rate response to inflation										
π_t	.070	.114	.101	.156	.102	.037	.188	.114	.069	.147	.012
π_{t-1}	.060	.089	.095	.085	.079	.029	.142	.091	.054	.107	.011
π_{t-2}	.057	.094	.080	.108	.079	.027	.117	.083	.052	.117	.011
π_{t-3}	.049	.106	.081	.067	.065	.022	.090	.075	.056	.081	.011
π_{t-4}	.054	.074	.069	.067	.058	.020	.075	.071	.045	.084	.009
π_{t-5}	.048	.079	.059	.056	.052	.018	.079	.061	.049	.0687	.009
π_{t-6}	.046	.072	.042	.023	.047	.015	.083	.047	.015	.069	.008
π_{t-7}	.033	.070	.027	.02	.045	.018	.063	.042	.021	.045	.006
π_{t-8}	.031	.061	.025	.011	.036	.015	.059	.023	.017	.046	.004
π_{t-9}	.020	.030	.025	-.006	.024	.010	.031	.015	.008	.028	.003
π_{t-10}	.012	.016	.005	-.006	.011	.004	.002	.007	.009	.019	.001
	interest rate response to output										
y_t	.601	.393	.859	.614	.712	.369	.413	-.522	.239	.581	.272
y_{t-1}	.427	.355	.388	.298	.355	.213	.270	-.272	.140	-.019	.098
y_{t-2}	.278	.195	.179	.096	.092	.109	.190	-.222	.084	.083	.053
y_{t-3}	-.043	.057	-.041	-.022	-.010	.058	.090	-.014	.061	-.081	.052
y_{t-4}	-.082	.107	-.095	-.015	-.020	.012	-.046	.034	.070	.094	.019
y_{t-5}	-.065	.030	-.238	-.092	-.030	-.046	-.043	.006	.006	-.038	-.021
y_{t-6}	-.0131	-.067	-.100	-.147	-.020	-.111	-.043	.075	.018	.071	.026
y_{t-7}	-.014	-.050	-.082	-.126	-.054	-.032	.002	.077	.039	-.017	-.019
y_{t-8}	-.000	-.052	-.090	-.100	-.124	-.007	-.042	.182	-.003	.087	-.009
y_{t-9}	.025	-.158	-.019	-.038	-.016	-.022	-.013	.061	-.010	-.015	.012
y_{t-10}	.039	-.047	.012	.034	-.044	.023	-.027	.028	.014	.097	.003
	interest rate response to past interest rates										
i_{t-1}	.670	.542	.729	.823	.653	.752	.681	.649	.790	.614	.943
i_{t-2}	-.051	-.079	-.029	-.012	-.047	-.024	-.039	-.047	-.017	-.057	-.002
i_{t-3}	-.048	-.075	-.026	-.011	-.044	-.022	-.036	-.044	-.016	-.053	-.001
i_{t-4}	-.045	-.069	-.024	-.010	-.041	-.020	-.033	-.040	-.014	-.048	-.001
i_{t-5}	-.040	-.063	-.021	-.008	-.036	-.017	-.029	-.035	-.012	-.043	-.001
i_{t-6}	-.035	-.056	-.018	-.007	-.032	-.015	-.025	-.031	-.010	-.037	-.001
i_{t-7}	-.030	-.048	-.015	-.006	-.027	-.012	-.021	-.026	-.008	-.030	-.001
i_{t-8}	-.024	-.039	-.012	-.005	-.021	-.010	-.016	-.021	-.006	-.024	-.001
i_{t-9}	-.018	-.029	-.009	-.003	-.016	-.007	-.012	-.015	-.005	-.017	.000
i_{t-10}	-.0012	-.019	-.006	-.002	-.010	-.004	-.008	-.010	-.003	-.011	.000
i_{t-11}	-.006	-.009	-.003	-.001	-.005	-.002	-.004	-.005	-.001	-.005	.000

Table 2: **Optimal feedback rule** ($\lambda = 1$, $\gamma = 0.5$)

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
	interest rate response to inflation										
π_t	0.052	.092	.075	.112	.077	.030	.0141	.088	.049	.111	.008
π_{t-1}	0.045	.071	.070	.060	.059	.023	.0106	.069	.038	.080	.007
π_{t-2}	.043	.075	.059	.077	.059	.021	.087	.063	.036	.087	.007
π_{t-3}	.036	.085	.060	.047	.048	.017	.067	.056	.039	.060	.007
π_{t-4}	.041	.057	.051	.047	.043	.015	.055	.053	.031	.062	.006
π_{t-5}	.036	.061	.043	.040	.038	.014	.059	.045	.034	.064	.006
π_{t-6}	.034	.056	.031	.016	.035	.011	.061	.035	.010	.051	.005
π_{t-7}	.024	.054	.020	.015	.033	.014	.047	.031	.015	.033	.004
π_{t-8}	.023	.047	.018	.007	.026	.011	.044	.017	.012	.033	.003
π_{t-9}	.014	.023	.018	-.004	.018	.007	.022	.011	.006	.020	.002
π_{t-10}	.009	.012	.004	-.004	.008	.003	.001	.005	.006	.014	.001
	interest rate response to output										
y_t	.432	.277	.581	.388	.486	.236	.279	-.353	.155	.393	.164
y_{t-1}	.308	.246	.258	.185	.239	.135	.180	-.181	.091	-.009	.059
y_{t-2}	.197	.130	.116	.057	.059	.068	.126	-.145	.054	.059	.032
y_{t-3}	-.033	.035	-.032	-.017	-.010	.036	.058	-.003	.039	-.052	.032
y_{t-4}	-.059	.070	-.067	-.012	-.016	.006	-.032	.028	.045	.066	.011
y_{t-5}	-.048	.015	-.163	-.060	-.022	-.030	-.030	.000	.004	-.023	-.012
y_{t-6}	-.093	-.050	-.069	-.094	-.015	-.071	-.029	.054	.012	.049	.016
y_{t-7}	-.010	-.037	-.056	-.080	-.038	-.021	.001	.054	.025	-.011	-.012
y_{t-8}	.000	-.037	-.061	-.064	-.085	-.004	-.028	.124	-.002	.059	-.005
y_{t-9}	.018	-.110	-.013	-.024	-.011	-.014	-.009	.041	-.007	-.010	.007
y_{t-10}	.028	-.032	.008	.021	-.030	.015	-.018	.019	.009	.065	.002
	interest rate response to past interest rates										
i_{t-1}	.746	.604	.772	.857	.706	.794	.732	.702	.829	.675	.962
i_{t-2}	-.038	-.060	-.020	-.008	-.034	-.017	-.028	-.034	-.011	-.041	-.001
i_{t-3}	-.036	-.056	-.019	-.007	-.032	-.015	-.025	-.032	-.010	-.037	-.001
i_{t-4}	-.033	-.051	-.017	-.006	-.029	-.013	-.023	-.028	-.009	-.034	-.001
i_{t-5}	-.030	-.046	-.015	-.005	-.026	-.012	-.020	-.025	-.008	-.029	-.001
i_{t-6}	-.026	-.040	-.012	-.005	-.022	-.010	-.017	-.022	-.006	-.025	-.001
i_{t-7}	-.022	-.034	-.010	-.004	-.018	-.008	-.014	-.018	-.005	-.020	.000
i_{t-8}	-.017	-.027	-.008	-.003	-.015	-.006	-.011	-.014	-.004	-.016	.000
i_{t-9}	-.013	-.020	-.006	-.002	-.011	-.004	-.008	-.010	-.003	-.011	.000
i_{t-10}	-.009	-.013	-.004	-.001	-.007	-.003	-.005	-.007	-.002	-.007	.000
i_{t-11}	-.004	-.007	-.002	-.001	-.004	-.001	-.003	-.003	-.001	-.003	.000

Table 3: **Optimal feedback rule** ($\lambda = 0.2$, $\gamma = 0.5$)

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
	interest rate response to inflation										
π_t	.020	.051	.081	.141	.061	.005	.159	.071	.048	.105	.006
π_{t-1}	.017	.038	.074	.075	.045	.004	.117	.053	.037	.072	.005
π_{t-2}	.016	.040	.060	.095	.044	.004	.094	.047	.035	.078	.005
π_{t-3}	.013	.045	.061	.057	.034	.004	.071	.041	.037	.051	.005
π_{t-4}	.015	.029	.051	.057	.030	.003	.057	.038	.029	.053	.004
π_{t-5}	.013	.032	.042	.047	.027	.003	.062	.031	.032	.055	.004
π_{t-6}	.013	.028	.029	.017	.024	.003	.065	.023	.008	.043	.003
π_{t-7}	.009	.027	.018	.016	.023	.003	.049	.021	.013	.026	.003
π_{t-8}	.008	.024	.017	.007	.018	.003	.046	.010	.011	.028	.002
π_{t-9}	.005	.011	.018	-.007	.012	.002	.022	.006	.005	.017	.001
π_{t-10}	.003	.006	.003	-.006	.005	.001	.000	.003	.006	.012	.001
	interest rate response to output										
y_t	.146	.113	.260	.163	.214	.090	.130	-.137	.065	.182	.042
y_{t-1}	.104	.098	.112	.075	.102	.050	.079	-.066	.036	-.001	.015
y_{t-2}	.065	.048	.050	.023	.023	.024	.056	-.052	.021	.029	.008
y_{t-3}	-.012	.010	-.015	-.007	-.007	.013	.026	.003	.016	-.022	.008
y_{t-4}	-.020	.024	-.030	-.005	-.009	.002	-.015	.014	.018	.031	.003
y_{t-5}	-.016	.002	-.073	-.024	-.011	-.012	-.014	.003	.001	-.010	-.003
y_{t-6}	-.031	-.023	-.031	-.038	-.007	-.027	-.013	.023	.005	.022	.004
y_{t-7}	-.003	-.017	-.025	-.033	-.017	-.008	.001	.022	.010	-.006	-.003
y_{t-8}	.000	-.017	-.027	-.026	-.038	-.002	-.012	.049	-.000	.026	-.001
y_{t-9}	.006	-.045	-.006	-.010	-.005	-.005	-.004	.016	-.003	-.005	.002
y_{t-10}	.010	-.013	.004	.009	-.013	.006	-.001	.008	.004	.029	.000
	interest rate response to past interest rates										
i_{t-1}	.909	.729	.848	.909	.799	.886	.818	.806	.897	.784	.998
i_{t-2}	-.0134	-.028	-.010	-.003	-.016	-.007	-.013	-.015	-.005	-.018	-.000
i_{t-3}	-.013	-.026	-.008	-.003	-.015	-.006	-.012	-.014	-.004	-.017	-.000
i_{t-4}	-.012	-.023	-.008	-.003	-.013	-.005	-.010	-.012	-.004	-.015	-.000
i_{t-5}	-.010	-.020	-.007	-.002	-.017	-.005	-.010	-.010	-.003	-.013	-.000
i_{t-6}	-.009	-.017	-.006	-.002	-.010	-.004	-.008	-.009	-.003	-.011	-.000
i_{t-7}	-.008	-.014	-.005	-.002	-.009	-.003	-.006	-.007	-.002	-.009	.000
i_{t-8}	-.006	-.011	-.004	-.001	-.007	-.002	-.005	-.006	-.002	-.007	.000
i_{t-9}	-.004	-.008	-.003	-.000	-.005	-.002	-.004	-.004	-.001	-.005	.000
i_{t-10}	-.003	-.005	-.002	-.001	-.003	-.001	-.002	-.003	-.001	-.003	.000
i_{t-11}	-.001	-.002	-.001	-.000	-.002	-.001	-.001	-.001	-.000	-.002	.000

Table 4: **Optimal feedback rule** ($\lambda = 5$, $\gamma = 0.5$)

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
	interest rate response to inflation										
π_t	0.085	0.152	0.088	0.101	.114	.069	.149	.125	.065	.150	.012
π_{t-1}	.077	.120	.084	.060	.091	.054	.118	.102	.053	.114	.011
π_{t-2}	.075	.127	.073	.073	.093	.049	.100	.097	.051	.126	.011
π_{t-3}	.064	.145	.075	.048	.078	.040	.080	.087	.056	.092	.011
π_{t-4}	.072	.103	.066	.048	.072	.036	.068	.089	.046	.095	.010
π_{t-5}	.064	.109	.058	.042	.065	.033	.071	.075	.050	.099	.009
π_{t-6}	.062	.101	.044	.020	.059	.027	.074	.060	.018	.081	.008
π_{t-7}	.045	.098	.030	.018	.056	.032	.058	.054	.023	.056	.007
π_{t-8}	.042	.086	.027	.011	.045	.027	.054	.033	.019	.054	.005
π_{t-9}	.027	.045	.025	-.001	.031	.017	.030	.021	.010	.034	.003
π_{t-10}	.0016	.024	.007	-.003	.014	.007	.005	.010	.010	.022	.001
	interest rate response to output										
y_t	.886	.608	1.37	1.04	1.13	.654	.654	-.849	.401	.949	.499
y_{t-1}	.630	.561	.633	.517	.571	.383	.440	-.455	.238	-.040	.179
y_{t-2}	.427	.325	.300	.174	.156	.199	.312	-.379	.142	.127	.098
y_{t-3}	-.056	.102	-.054	-.028	-.007	.110	.148	-.004	.104	-.145	.096
y_{t-4}	-.120	.186	-.143	-.018	-.023	.027	-.069	.039	.118	.145	.035
y_{t-5}	-.093	.070	-.374	-.152	-.041	-.079	-.066	-.023	.010	-.071	-.038
y_{t-6}	-.197	-.093	-.0157	-.246	-.027	-.196	-.066	.112	.032	.111	.048
y_{t-7}	-.023	-.071	-.129	-.212	-.084	-.057	.005	.120	.066	-.032	-.036
y_{t-8}	.001	-.075	-.143	-.170	-.196	-.012	-.066	.295	-.006	.142	-.016
y_{t-9}	.035	-.253	-.030	-.065	-.025	-.0138	-.022	.100	-.018	-.024	.023
y_{t-10}	.058	-.075	.019	.057	-.069	.041	-.043	.045	.023	.161	.005
	interest rate response to past interest rates										
i_{t-1}	.589	.451	.667	.775	.575	.681	.608	.572	.729	.525	.916
i_{t-2}	-.068	-.111	-.043	-.019	-.070	-.040	-.058	-.069	-.028	-.086	-.003
i_{t-3}	-.065	-.107	-.039	-.018	-.066	-.037	-.055	-.065	-.026	-.081	-.003
i_{t-4}	-.061	-.101	-.036	-.016	-.061	-.033	-.050	-.060	-.023	-.075	-.002
i_{t-5}	-.056	-.093	-.032	-.014	-.055	-.029	-.045	-.054	-.020	-.067	-.002
i_{t-6}	-.049	-.084	-.028	-.012	-.049	-.025	-.039	-.048	-.017	-.059	-.002
i_{t-7}	-.043	-.073	-.023	-.010	-.041	-.021	-.033	-.041	-.014	-.049	-.001
i_{t-8}	-.034	-.061	-.018	-.008	-.033	-.016	-.026	-.033	-.011	-.039	-.001
i_{t-9}	-.026	-.046	-.014	-.006	-.025	-.012	-.019	-.024	-.007	-.028	-.001
i_{t-10}	-.017	-.030	-.010	-.004	-.017	-.008	-.013	-.016	-.005	-.018	.000
i_{t-11}	-.009	-.015	-.005	-.002	-.008	-.004	-.006	-.008	-.002	-.009	.000

Table 5: **Correlation of desired and decided interest rates ($\lambda = 1$, $\gamma = .5$) in percent.**

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa	ECB
	Corr. between decided and desired interest rates $\lambda = 1$, $\gamma = .5$											
ECB Rule	57	56	56	91	88	69	75	28	91	34	92	99.8
Nationalistic	34	59	55	84	66	59	60	60	77	38	89	n.a.
	Corr. between decided and desired interest rates $\lambda = 1$, $\gamma = .25$											
ECB Rule	57	49	68	92	90	79	82	46	89	35	95	99.95
Nationalistic	62	56	51	80	74	73	66	37	88	40	87	n.a.
	Corr. between decided and desired interest rates $\lambda = .2$, $\gamma = .5$											
ECB Rule	87	85	75	95	95	93	87	80	96	55	98	99.94
Nationalistic	82	83	63	86	79	91	76	73	95	38	98	n.a.
	Corr. between decided and desired interest rates $\lambda = 5$, $\gamma = .5$											
ECB Rule	30	29	4	83	84	40	65	10	69	35	86	99.5
Nationalistic	49	45	47	58	56	52	43	26	80	26	69	n.a.

Table 6: **Loss Function**

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
	$\lambda = 0.2$, $\gamma = 0.5$										
Benchmark											
π	.0004	.0004	.0152	.0153	.0215	.0297	.0422	.0424	.0441	.0917	.0933
y	.1328	.1096	.1255	.0629	.0730	.1582	.1321	.1535	.0714	1.342	.0897
R	.001	.0008	.0019	.0005	.0010	.0006	.0013	.0006	.0006	.0059	.0001
Loss	.0275	.0227	.0413	.0281	.0365	.0616	.0693	.0734	.0587	.3215	.1113
Av.Loss	.0775										

	$\lambda = 0.2$, $\gamma = 0.5$										
ECB Rule	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
π	.0004	.0004	.0156	.0256	.0347	.0415	.0460	.0434	.0457	.0926	.0944
y	.1346	.1474	.1280	.0773	.0855	.1279	.1180	.1513	.0713	1.1501	.0897
EMU R	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006	.0006
Loss	.0276	.0302	.0415	.0414	.0521	.0674	.0699	.0742	.0602	.3229	.1126
Av. Loss	.1065										
Nationalistic											
π	.0004	.0004	.0138	.0154	.0215	.0297	.0423	.0453	.0468	.1332	.1368
y	.1480	.1118	.1426	.0631	.0739	.1591	.1331	.2208	.0792	1.1572	.0997
EMU R	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004
Loss	.0302	.0230	.0425	.0282	.0365	.0617	.0691	.0897	.0629	.3648	.1569
Av.Loss	.0878										

Table 7: **Loss Function**

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
	$\lambda = 1$, $\gamma = 0.25$										
Benchmark											
π	.0003	.0004	.0061	.0137	.0170	.0206	.0305	.0275	.0393	.0829	.0804
y	.1351	.1335	.0944	.0601	.0702	.1471	.1252	.1623	.0772	1.0940	.0790
R	.0032	.0019	.0043	.0015	.0016	.0015	.0020	.0039	.0005	.0262	.0014
Loss	.1362	.1343	.1016	.0741	.0876	.1681	.1562	.1908	.1167	1.1835	.1597
Av. Loss	.2281										
	$\lambda = 1$, $\gamma = 0.25$										
ECB Rule	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
π	.0003	.0004	.0063	.0137	.0176	.0203	.0322	.0295	.0420	.0829	.0825
y	.1375	.1355	.0956	.0602	.0701	.1478	.1250	.1618	.0772	1.1040	.0790
EMU R	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.0015
Loss	.1381	.1362	.1022	.0743	.0880	.1685	.1576	.1918	.1191	1.1871	.1617
Av. Loss	.2295										
Nationalistic											
π	.0004	.0005	.0105	.0163	.0276	.0339	.0335	.0290	.0312	.1117	.1086
y	.1415	.1026	.1088	.0727	.0834	.1198	.1325	.2111	.0733	1.2176	.1337
EMU R	.0009	.0009	.0009	.0009	.0009	.0009	.0009	.0009	.0009	.0009	.0009
Loss	.1422	.1034	.1195	.0892	.1112	.1540	.1662	.2403	.1048	1.3295	.2426
Av.Loss	.2548										

Table 8: **Loss Function**

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
	$\lambda = 1$, $\gamma = 0.5$										
Benchmark											
π	.0004	.0007	.0159	.0219	.0244	.0436	.0333	.0378	.0402	.1192	.0915
y	.1393	.1170	.1208	.0696	.0761	.1341	.1131	.1874	.0795	1.1041	.1006
R	.0097	.0047	.0092	.0027	.0024	.0043	.0024	.0110	.0012	.0518	.0010
Loss	.1446	.1200	.1413	.0929	.1017	.1799	.1476	.2307	.1202	1.2492	.1926
Av. Loss	.2473										

	$\lambda = 1$, $\gamma = 0.5$										
ECB Rule	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
π	.0004	.0005	.0168	.0242	.0252	.0324	.0335	.0379	.0400	.0961	.0935
y	.1462	.1252	.1246	.0805	.0764	.1586	.1145	.1925	.0799	1.1737	.1006
EMU R	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024
Loss	.1478	.1269	.1427	.1059	.1032	.1921	.1492	.2316	.1211	1.271	.1954
Av. Loss	.2534										
Nationalistic											
π	.0006	.0007	.0261	.0350	.0357	.0450	.0558	.0660	.0673	.1208	.1195
y	.1963	.1194	.1512	.0698	.0695	.1348	.1220	.1698	.0777	1.1275	.0975
EMU R	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022
Loss	.1981	.1212	.1784	.1059	.1063	.1808	.1789	.2369	.1461	1.2494	.2181
Av.Loss	.2654										

Table 9: **Loss Function**

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
	$\lambda = 5$, $\gamma = 0.5$										
Benchmark											
π	.0003	.0006	.0105	.0204	.0298	.0383	.0426	.0395	.0416	.1132	.0803
y	.1159	.1112	.0914	.0629	.0825	.1353	.1089	.1549	.0662	1.1914	.0982
R	.0377	.0238	.0539	.0194	.0290	.0291	.0285	.0609	.0083	.2794	.0085
Loss	.5987	.5685	.4945	.3446	.4568	.7294	.6014	.8445	.3768	6.2099	.5756
Av. Loss	1.0728										

	$\lambda = 5$, $\gamma = 0.5$										
ECB Rule	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
π	.0003	.0003	.0190	.0222	.0319	.0387	.0410	.0394	.0411	.1176	.1229
y	.1218	.1399	.1512	.0635	.0858	.1459	.1212	.1680	.0665	1.2563	.1009
EMU R	.0111	.0111	.0111	.0111	.0111	.0111	.0111	.0111	.0111	.0111	.0111
Loss	.6149	.7054	.7806	.3453	.4665	.7738	.6526	.8850	.3792	6.4047	.6330
Av. Loss	1.1491										
Nationalistic											
π	.0005	.0006	.0114	.0210	.0334	.0416	.0458	.0421	.400	.0923	.0915
y	.1693	.1158	.0950	.0664	.0931	.1380	.1112	.1623	.0803	1.2908	.0983
EMU R	.0126	.0126	.0126	.0126	.0126	.0126	.0126	.0126	.0126	.0126	.0126
Loss	.8533	.5859	.4927	.3593	.5052	.7379	.6081	.8599	.4478	6.5526	.5893
Av.Loss	1.1447										

Table 10: **Correlation of desired and decided interest rates (asymmetric preferences) in percent.**

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa	ECB
	Corr. between decided and desired interest rates (asymmetric preferences)											
ECB Rule	50	55	55	83	24	21	63	23	87	31	86	99.6
Nationalistic	50	58	45	71	61	38	31	74	79	37	51	n.a.

Table 11: **Loss Functions with Asymmetric Preferences**

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
ECB Rule											
π	.0004	.0004	.0245	.0423	.0270	.0519	.0541	.0419	.0400	.1153	.1168
y	.1509	.1259	.1568	.0636	.0753	.1471	.1172	.2163	.0802	1.2549	.1009
EMU R	.0055	.0055	.0055	.0055	.0055	.0055	.0055	.0055	.0055	.0055	.0055
Loss	.1540	.1291	.1841	.3631	.1051	.7902	.6429	.2610	.1230	6.3926	.6241
Av. Loss	.8881										
Nationalistic											
π	.0003	.0003	.0234	.0373	.0328	.0455	.0335	.0380	.0343	.0869	.0824
y	.1493	.1411	.1507	.0619	.0869	.1406	.1151	.1951	.0858	1.2501	.1104
EMU R	.0042	.0042	.0042	.0042	.0042	.0042	.0042	.0042	.0042	.0042	.0042
Loss	.1517	.1435	.1762	.3489	.1218	.7506	.6111	.2352	.1222	6.3395	.6365
Av.Loss	.8761										

Countries with high weight on output stabilization ($\lambda = 5, \gamma = 0.5$): France, Ireland, Italy, Portugal and Spain. Countries with low weight on output stabilization ($\lambda = 1, \gamma = 0.5$) : Austria, Belgium, Finland, Germany, Luxembourg and the Netherlands.

Table 12: **Correlation of desired and decided interest rates with symmetric versus asymmetric shocks in percent.**

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa	ECB
ECB Rule	Corr. between decided and desired interest rates (asymmetric shocks)											
Asymmetry	58	40	48	82	86	69	79	21	85	20	90	99.6
Symmetry	62	56	61	92	90	79	80	40	93	33	93	99.7

Table 13: **Loss Functions with Symmetric versus Asymmetric Shocks**

	Aus	Bel	Fin	Fra	Ger	Ire	Ita	Lux	Net	Por	Spa
ECB Rule											
Asymmetry											
π	.0002	.0002	.011	.014	.019	.022	.024	.021	.024	.097	.107
y	.141	.126	.137	.062	.075	.165	.110	.212	.077	1.482	.117
EMU R	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019
Loss	.141	.127	.149	.077	.095	.188	.135	.234	.102	1.580	.225
Av. Loss	.2757										
Symmetry											
π	.0003	.0003	.0155	.0179	.0189	.0239	.0319	.0318	.0368	.0619	.0616
y	.0955	.1061	.1133	.0705	.0870	.1159	.1093	.1391	.0927	1.6295	.0964
EMU R	.0048	.0048	.0048	.0048	.0048	.0048	.0048	.0048	.0048	.0048	.0048
Loss	.0982	.1088	.1312	.0908	.1003	.1422	.1436	.1733	.1319	1.6938	.1604
Av.Loss	.2431										

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